Upper Extremity Fracture

From HumanResearchWiki

Contents

Introduction

In both a microgravity and a partial gravity environment, impact forces from falls or collisions with stationary or moving objects will be less likely to cause fracture compared with the terrestrial 1 Gravity (G) environment; however, fractures are still a possibility, especially during translation of high mass objects, during exercise, and during Extravehicular Activity (EVA). Apollo-era crewmembers who explored the lunar surface remarked that with the mechanics of the lunar gravity, falling on an outstretched hand during an EVA could have resulted in sufficient momentum that could have caused a wrist fracture.[1]

In addition, impact from large moving objects (spacecraft hardware, surface exploration rovers, large rocks) may be of sufficient momentum to impart high impact loads, and lead to fracture of small bones. Fractures of larger, weight-bearing bones are thought to be less likely, even with the bone demineralization that occurs in those bones. Although EVA suits provide attenuation of impact loads and may therefore provide protection from some types of trauma, they are not worn when astronauts are within the space craft or surface habitats. Guided ultrasound is available to assist with diagnosis when needed. The crew is trained to use available dressings and splints as needed. Appropriate analgesics are available on board as well.[2]

Clinical Priority and Clinical Priority Rationale by Design Reference Mission

One of the inherent properties of space flight is a limitation in available mass, power, and volume within the space craft. These limitations mandate prioritization of what medical equipment and consumables are manifested for the flight, and which medical conditions would be addressed. Therefore, clinical priorities have been assigned to describe which medical conditions will be allocated resources for diagnosis and treatment. "Shall" conditions are those for which diagnostic and treatment capability must be provided, due to a high likelihood of their occurrence and severe consequence if the condition were to occur and no treatment was available. "Should" conditions are those for which diagnostic and treatment capability should be provided if mass/power/volume limitations allow.

Conditions were designated as "Not Addressed" if no specific diagnostic and/or treatment capability are expected to be manifested, either due to a very low likelihood of occurrence or other limitations (for example, in medical training, hardware, or consumables) that would preclude treatment. Design Reference Missions (DRMs) are proposed future missions designated by a set of assumptions that encompass parameters such as destination, length of mission, number of crewmembers, number of Extravehicular Activities (EVAs), and anticipated level of care. The clinical priorities for all medical conditions on the Exploration Medical Condition List (EMCL) can be found here (https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All_DRM). The EMCL document may be accessed here (https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
Lunar sortie mission Assumptions: ▪ 4 crewmembers (3 males, 1 female) ▪ 14 days total ▪ 4 EVAs/crewmember ▪ Level of Care 3	Not Addressed	Due to the relatively short duration of the lunar sortie mission, an upper extremity fracture would be managed until return to Earth with symptomatic treatment alone (analgesics) that are available for other conditions such as Extremity Sprains/Strains.
Lunar outpost mission Assumptions: ▪ 4 crewmembers (3 males, 1 female) ▪ 180 days total ▪ 90 EVAs/crewmember ▪ Level of Care 4	Should	Due to the long-duration nature of the lunar outpost mission, treatment to address an upper extremity fracture beyond analgesia should be manifested if mass and volume constraints allow.
Near-Earth Asteroid (NEA) mission Assumptions: ▪ 3 crewmembers (2 males, 1 female) ▪ 395 days total ▪ 30 EVAs/crewmember ▪ Level of Care 5	Should	Crewmembers in the microgravity environment of the NEA mission will be unlikely to sustain anything more than minor musculoskeletal trauma or strain. However, there is a potential for relatively minor hand and wrist injuries that would involve fracture of the smaller bones, which would necessitate specific treatment beyond that included under the condition Extremity Sprains/Strains. Therefore, manifesting diagnostic and treatment capability is recommended if mass/volume allow.

Initial Treatment Steps During Space Flight

A link is provided to a prior version of the International Space Station (ISS) Medical Checklist, which outlines the initial diagnostic and treatment steps recommended during space flight for various conditions which may be encountered onboard the ISS. Further diagnostic and treatment procedures beyond the initial steps outlined in the Medical Checklist are then recommended by the ground-based Flight Surgeon, depending on the clinical scenario. Please note that this version does not represent current diagnostic or treatment capabilities available on the ISS. While more recent versions of this document are not accessible to the general public, the provided version of the checklist can still provide a general sense of how medical conditions are handled in the space flight environment. Medical Checklists will be developed for exploration missions at a later point in time.

Please note this file is over 20 megabytes (MB) in size, and may take a few minutes to fully download.

ISS Medical Checklist (http://www.nasa.gov/centers/johnson/pdf/163533main_ISS_Med_CL.pdf)

Capabilities Needed for Diagnosis

The following is a hypothetical list of capabilities that would be helpful in diagnosis. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Vital signs measurement capability (blood pressure, pulse, respiratory rate, pulse oximetry, as required per the patient's clinical state)
- Doppler (to assess distal pulses)
- Imaging [such as ultrasound, X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), bone scan]
- Tissue pressure sensor (for ruling out compartment syndrome)

Capabilities Needed for Treatment

The following is a hypothetical list of capabilities that would be helpful in treatment. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Structural Aluminum Malleable (SAM®) splint
- All Cotton Elastic (ACE™) wrap
- Casting materials
- Analgesics (non-narcotic, narcotic, oral, injectable)
- Sharps container
- Non-sterile gloves (pair)
- Skin cleanser [such as alcohol/Benzalkonium antiseptic (BZK)/iodine]
- Bandages

Associated Gap Reports

The NASA Human Research Program (HRP) identifies gaps in knowledge about the health risks associated with human space travel and the ability to mitigate such risks. The overall objective is to identify gaps critical to human space missions and close them through research and development. The gap reports that are applicable to this medical condition are listed below. A link to all of the HRP gaps can be found here (http://humanresearchroadmap.nasa.gov/Gaps/).

2.01 - We do not know the quantified health and mission outcomes due to medical events during exploration missions.
2.02 - We do not know how the inclusion of a physician crew medical officer quantitatively impacts clinical outcomes during exploration missions.
3.01 - We do not know the optimal training methods for in-flight medical conditions identified on the Exploration Medical Condition List taking into account the crew medical officer's clinical background. (Closed)
4.01 - We do not have the capability to provide a guided medical procedure system that integrates with the medical system during exploration missions.
4.02 - We do not have the capability to provide non-invasive medical imaging during exploration missions.
4.06 - We do not have the capability to stabilize bone fractures and accelerate fracture healing during exploration missions.
4.07 - Limited wound care capability to improve healing following wound closure (Closed)
4.08 - We do not have the capability to optimally treat musculoskeletal injuries during exploration missions.
4.14 - We do not have the capability to track medical inventory in a manner that integrates securely with the medical system during exploration missions.
4.15 - Lack of medication usage tracking system that includes automatic time stamping and crew identification
4.17 - We do not have the capability to package medications to preserve stability and shelf-life during exploration missions.
4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)
5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

Other Pertinent Documents

List of Acronyms

A	
ACE™	All Cotton Elastic
B	
BZK	Benzalkonium antiseptic
C	
CT	Computed Tomography
D	
DRM	Design Reference Mission
E	
EMCL	Exploration Medical Condition List

EVA	Extravehicular Activity
G	
G	Gravity
H	
HRP	Human Research Program
I	
ISS	International Space Station
M	
MB	Megabyte
MRI	Magnetic Resonance Imaging
N	
NASA	National Aeronautics and Space Administration
NEA	Near Earth Asteroid
S	
SAM®	Structural Aluminum Malleable

References

1. Scheuring RA, Jones JA, Novak J et al. The Apollo Medical Operations Project: Recommendations to improve crewhealth and performance for future exploration missions and lunar surface operations. Acta Astronautica 2008;2008(63):980-987.
2. Scheuring RA, Mathers CH, Jones JA, Wear ML. Musculoskeletal injuries and minor trauma in space: incidence and injury mechanisms in U.S. astronauts. Aviat Space Environ Med 2009 Feb;80(2):117-24.

Last Update

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Category: Medical Conditions
